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Joint Report of A. M. Hunt and C. L.  
Cory, Consulting Engineers, on the  
Character and Quality of Gas Fur-  
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with Special Reference to Complaints  
Against High Bills During the Months  
of December, 1908, and January and  
February, 1909.

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169 McAllister Street, S. F.

# **Joint Report of A. M. Hunt and C. L. Cory, Consulting Engineers, on the Character and Quality of Gas Furnished to the City of San Francisco With Special Reference to Complaints Against High Bills During the Months of December, 1908, and January and February, 1909.**

San Francisco, April 9, 1909.  
To the Committee on Artificial Lights,  
Board of Supervisors, City and  
County of San Francisco, California.

Gentlemen: At your request, we have made as full an investigation as possible into the character and quality of the gas supplied in the city of San Francisco, with especial reference to the complaints of high bills during the months of December, 1908, and January and February, 1909.

There being no records available for the months in question, except those of the companies supplying gas, we have been compelled to use their records, supplementing them with such investigations as we have been able to make ourselves during the past three weeks.

The results of our investigations have been negative so far as disclosing any general condition that could account for abnormal bills during the past winter, except that the winter months are always those of maximum use of gas, and that the months of January and February were abnormal as regards the large amount of cloudy and cold weather. It is also a fact that the San Francisco Gas & Electric Company have since July, 1908, been collecting a rate of \$1.00 per thousand for gas, while for two years prior to that date, they had collected only 85c per thousand. The increase of rate amounts to about 17 2-3 per cent. The average increased use during the months above noted cannot be deter-

mined, but that it was materially higher than for the same months of a normal winter is certain.

The time and facilities available made it impossible to test a sufficient number of meters (there being over 60,000 in use) to ascertain the average accuracy of all the meters in use.

Our method of procedure in reference to meter testing was as follows:

We received from various sources eighty-one complaints of high bills. Of these, twenty-four were selected after investigation of the data, and the meters were taken out and tested by us, using a standard meter prover.

Seven of the meters were found correct within one per cent; twelve were fast, the average being 2.87 per cent; and five were slow, the average being 4.2 per cent. The maximum percentage fast was six per cent, and the maximum percentage slow was seven per cent.

The facts disclosed do not show a condition of affairs as regards the meters which can be considered as serious.

The most flagrant case, so far as appearances go, brought to our notice was one in which the bill from Jan. 12th to Feb. 11th, 1909, was given as \$1.70, and from Feb. 11th to Feb. 26th, 1909, as \$11.85. On this latter date, the customer discontinued his service with the company which had been supplying him and took gas from the other company.

An examination and analysis of his bills for the periods preceding and following the dates above given are instructive, as noted below.

STATEMENT OF GAS ACCOUNT.

Meter set March 12, 1908, at zero.

| Date.                             | Cu. Ft.<br>used. | No. of<br>days. | Rate per<br>1000. | Cu. Ft.<br>per day. | Charge. |
|-----------------------------------|------------------|-----------------|-------------------|---------------------|---------|
| Apr. 13th.....                    | 20,200           | 32              | 75c               | 631                 | \$15.15 |
| May 13th.....                     | 20,200           | 30              | 75c               | 670                 | 15.15   |
| June 11th.....                    | 32,400           | 29              | 70c               | 1119                | 22.70   |
| July 14th.....                    | 18,800           | 33              | 80c               | 570                 | 15.05   |
| Aug. 14th.....                    | 10,400           | 31              | 80c               | 335                 | 8.30    |
| Sept. 14th.....                   | 14,400           | 31              | 80c               | 464                 | 11.50   |
| Oct. 14th.....                    | 10,800           | 30              | 80c               | 360                 | 8.65    |
| Nov. 13th.....                    | 17,400           | 30              | 80c               | 580                 | 13.90   |
| Dec. 11th.....                    | 25,200           | 28              | 75c               | 900                 | 18.90   |
| Jan. 12th.....                    | 9,400            | 32              | 85c               | 294                 | 8.00    |
| Feb. 11th.....                    | 2,000            | 30              | 85c               | 63                  | 1.70    |
| Feb. 26th.....                    | 14,800           | 15              | 45                | 987                 | 11.85   |
| Changed to other company.         |                  |                 |                   |                     |         |
| Meter set Feb. 24, 1908, at zero. |                  |                 |                   |                     |         |
| Mar. 9th.....                     | 10,800           | 13              | 75c               | 830                 | 8.10    |
| Mar. 24th.....                    | 12,600           | 15              | 75c               | 840                 | 9.45    |

The quality of gas supplied by both the San Francisco Gas & Electric Company and the Metropolitan Light & Power Company is excellent.

On March 23rd, 1909, the gas being delivered into the mains by the S. F. G. & E. Co. had a candle power of 23.6 with a gross heat value of 710 British Thermal Units. The records of the Company for the past year indicate that this same high standard has been maintained during that period.

The gas of the Metropolitan Light & Power Co., on April 6, 1909, had a candle power of 18.8 and a gross heat value of 651 British Thermal Units. From the Company's records the average candle power for the month of December, 1908, was 19.13; for the month of January, 1909, 19.58. The average gross heat value (also from the Company's records) during these months was, Dec., 1908, 652 British Thermal Units; Jan., 1909, 690 British Thermal Units.

It can be definitely stated that the gas supplied by both these companies is of as high or higher quality as regards heat value than any artificial gas supplied to any other community of which we have been able to find records.

The analyses of the two gases obtained by us are appended. The question has been raised as to the amount of carbon monoxide contained in the gas supplied in San Francisco. The analyses obtained by us show that the gas sent out by the S. F. G. & E. Co. contained 12.6 per cent carbon monoxide on March 23rd, 1909, and that of the Metropolitan Co. 4 per cent on April 6th, 1909. In practically all the large communities of this country, except on the Pacific Coast, the gas is

made by what is known as the carburetted water gas process, and usually contains about 26 per cent of carbon monoxide. It will be seen that both the gases supplied in San Francisco contain only a fraction as much of this component as exists in the bulk of the gas which is distributed in Eastern communities. The relatively larger amount contained in the gas of the S. F. G. & E. Co. as compared with that of the Metropolitan Co. is due to the fact that the former company manufactures both oil gas and carburetted water gas, which are mixed before being distributed.

An examination of the analyses shows that neither gas had been admixed with air. It is not generally known that the admixture of air with an illuminating gas cuts down its candle power very rapidly. To illustrate this we had candle power tests made on gas containing various percentages of air. Results are given in the table below.

| % of air mixed<br>with the gas. | Loss of candle<br>power in % of<br>that of unmixed<br>gas. |
|---------------------------------|--|
| 1%                              | 8%   |
| 3%                              | 16%  |
| 5%                              | 26.2%  |
| 8%                              | 33.8%  |
| 12%                             | 58.7%  |
| 15%                             | 71.1%  |

It is readily seen that any attempt to dilute the gas with air to increase its volume by an appreciable amount will be accompanied by such a serious loss of candle power as to betray the fact at once.

It has been claimed that a gas company can, by increasing pressure on its mains, force gas through the meters

into the house pipes, and that this gas will, when the pressure is again lowered, pass back into the mains, the net result being that the meter records gas that has not been used. To ascertain if this be possible, we connected the outlet of a new and tested meter to a tank having a volume equal to the entire pipe system of an average house. The inlet side of the meter was connected to a small tank containing gas, in which the pressure could be varied from a low pressure ( $1\frac{1}{2}$  inches of water) to the maximum pressure on the mains. After carefully noting the position of the pointer of the test dial of the meter, the pressure was varied between the extreme limits ninety (90) times. This would represent the probable number of fluctuations of pressure in the mains during the period of a month, arising from the three peaks per day caused by the heavy demand for gas for cooking. At the conclusion of the test, the pointer had apparently not moved at all. The test was a severe one, and eliminates the above theory completely.

A test was made to determine the effect of the change of pressure of gas upon the economy with which it is used in an ordinary gas range for general cooking purposes. In this test the pressure of the gas was artificially varied through a wide range, from a minimum of .5 inch to 6.1 inches of water, or a total variation of 5.6 inches. The adjustment of the burner was so made as to give what was considered the most satisfactory gas flame under a four-inch pressure, and all of the tests were made with no change whatsoever being made in this arrangement of the burner.

In order to measure the amount of gas required to do an equal amount of heating under the different pressures, one gallon of water was in each case heated in an ordinary granite-ware tea kettle, and enough gas was burned to increase the temperature of the water 100 degrees Fahr., the initial temperature of the water in each case being about 60 degrees Fahr.

During the test the amount of gas used was measured by both a new meter which had previously been tested, and found correct, and by the prover, which is ordinarily used for testing the accuracy of the meters.

The complete results of these tests are given below:

| Pressure<br>of Gas. | Cu. Ft.<br>of Gas. | Time<br>Required. |
|---------------------|--------------------|-------------------|
| 0.5 inch            | 3.45               | 19 min. 46 sec.   |
| 2.0 inches          | 3.80               | 9 " 32 "          |
| 4.0 "               | 4.35               | 8 " 4/5 "         |
| 6.1 "               | 4.24               | 5 " 52 "          |

An examination of the results of the test shows conclusively that while the length of time required to heat the given quantity of water was much greater for the lower pressures, yet the amount of gas consumed was less at the lower pressure, so that the claimed excessive bills during December and January could not have been due to extreme low pressure.

In this connection it should be noted that the maximum fluctuations of pressure found by us, after taking simultaneously twenty-four records at five different places, was in the Richmond District on 25th avenue, north of Lake street, which on April 1st showed a fluctuation of 6.4 inches.

We earnestly recommend that the City establish a laboratory and equip it with instruments so that the City gas inspector can make regular tests. Such a laboratory should be located at a point where service pipes may be run in from the mains of both companies supplying gas. It should be equipped with the following instruments:

One (1) standard 5-ft. meter prover, complete.

One (1) 100-inch standard bar photometer.

One (1) candle balance.

One (1) Pentane lamp, 10 candle power.

One (1) Junker calorimeter, for gas.

One (1) Hempel gas analysis apparatus.

One (1) dozen sample tubes for gas.

The necessary supply of glassware, re-agents, tubes, etc. In addition to the above there should be provided at least four seven-day pressure recording gauges and two 24-hour pressure recording gauges.

The above equipment will cost installed not to exceed two thousand dollars (\$2000.00).

The gas inspector should be required to make analyses, candle power and heat value determinations of the gas at least three (3) times each week, keeping permanent record of his results. The four seven-day pressure gauges should be installed at carefully selected points, and continuous records of the pressure obtained at these points should be kept on file. One of the 24-hour gauges should be installed in the laboratory, the other being available for use at any point from which complaints of low or heavily fluctuating pressure are received. The total lack of such data as is noted above has made it impossible for us to ascertain the conditions obtaining during the past winter, when gas consumption was heavy and complaints of high gas bills were most frequent.

In conclusion we can only report that we have discovered no facts which indicate that the gas companies have during the past winter done anything which would increase the amount of gas used by consumers. The gas at present supplied is undeniably of high quality, and the records of the companies substantiate their claim that this was also the case during last December, January and February.

The results of our meter tests qualify the statement that the meters in use are of good, reliable make, and record correctly within the commercial limits of accuracy.

Undoubtedly there have been, and will always be, sporadic cases where complaints are just, and gas meters will also be found which record incorrectly.

The San Francisco Gas & Electric Company and the Metropolitan Light & Power Company have shown us every courtesy and accorded us every facility asked for.

Respectfully submitted,

A. M. HUNT,  
C. L. CORY.

*Analysis of gas at works of S. F. G. & E. Co. March 23, 1909.*

|                          |       |
|--------------------------|-------|
| Heavy hydrocarbons ..... | 10%   |
| Marsh gas .....          | 32%   |
| Hydrogen .....           | 36.1% |
| Carbonic oxide .....     | 12.6% |
| Carbonic acid gas.....   | 3.4%  |
| Oxygen .....             | 0.2%  |
| Nitrogen .....           | 5.7%  |

Candle power—23.6. Heat value—  
710 B. T. U.

100.0%

*Analysis of sample of gas taken from S. F. G. & E. Co.'s mains at 3245 Twenty-first street.*

|                          |       |
|--------------------------|-------|
| March 31st, 1909.        |       |
| Heavy hydrocarbons ..... | 8.4%  |
| Marsh gas .....          | 32.5% |
| Hydrogen .....           | 39.0% |
| Carbonic oxide .....     | 10.2% |
| Carbonic acid gas.....   | 3.2%  |
| Oxygen .....             | 0.2%  |
| Nitrogen .....           | 6.5%  |

100.0%

Heat value—686 B. T. U.

*Analysis of sample of gas taken from the mains of the S. F. G. & E. Co. at 154 Lake street on*

|                          |       |
|--------------------------|-------|
| March 31st, 1909.        |       |
| Heavy hydrocarbons ..... | 8.6%  |
| Marsh gas .....          | 32.1% |
| Hydrogen .....           | 38.5% |
| Carbonic oxide .....     | 11.2% |
| Carbonic acid gas.....   | 3.0%  |
| Oxygen .....             | 0.2%  |
| Nitrogen .....           | 6.4%  |

Heat value—687 B. T. U.

100.0%

*Analysis of gas of Metropolitan Light & Power Co.*

|                                 |       |
|---------------------------------|-------|
| April 6th, 1909.                |       |
| Benzene .....                   | 1.2%  |
| Acetylene and other illuminants | 5.6%  |
| Carbon monoxide .....           | 4.0%  |
| Methane .....                   | 35.2% |
| Hydrogen .....                  | 40.9% |
| Carbon Dioxide .....            | 2.2%  |
| Oxygen .....                    | 1.5%  |
| Nitrogen .....                  | 9.4%  |

100.0%

Candle power—18.8. Heat value—  
650.8 B. T. U.

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## Note by San Francisco Gas & Electric Company

From the foregoing report of two able and disinterested experts it is demonstrated, that the character of gas supplied by the San Francisco Gas & Electric Company is better than the average standard of gas furnished elsewhere in the United States, both as to its candle power and heat-giving qualities. It is also apparent that the very vicious criticism of the Company was totally undeserved and unwarranted.

The aim of the Company is to give good service, and it invites at all times honest criticism and complaints of consumers, and will endeavor to right any and all wrongs, its motto being:

“Solve all doubts in favor of the consumer.”

JOHN A. BRITTON, President.















